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area, aside from that of the Connecticut Valley, being included in a narrow belt extending the entire length of the State west of the Green Mountains. Throughout its extent white oak, bitter hickory, pitch and red pine, sweet-fern and frost grape are common, mingling at the northern end of Lake Champlain with the Canadian arbor vitæ and white spruce. The chestnut, button-wood and mountain laurel probably do not exist much north of Burlington.

The following species which are to be met with in New York and further westward do not appear to be found east of the Connecticut Valley, and most of them are confined to the immediate vicinity of the river: *Carya amara*, *Celtis occidentalis*, *Populus monilifera*, *Salix longifolia*, and *Salix livida*, var. *occidentalis*; the last one of these having the widest distribution being found throughout the entire valley, but apparently not passing over the water-shed into the Merrimack district. The hairy-leaved white violet (*Viola renifolia*, Gray; n. sp.) is to be met with between the mouth of the Passumpsic and Plainfield, N. H.

The following may be called rare, having but a single locality for each: *Lobelia Kalmii*, ledges at the foot of Fifteen Miles Falls; *Cypripedium pubescens*, at Hanover; *Arabis Drummondii*, on an island in the river just south of White River Junction; and *Astragalus Robbinsii*, rocks at Quechee Falls, Plainfield, N. H.

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## THE SUESSONIAN FAUNA IN NORTH AMERICA.

BY PROF. E. D. COPE.

IN a paper read before the National Academy of Sciences at the spring session of 1876 in Washington, the writer announced the identification of the Wahsatch Eocene formation of New Mexico with the Suessonian or Lower Eocene of France and England. The beds, which were explored while connected with the United States Geographical and Geological Survey, west of the one hundredth meridian, in charge of Lieut. G. M. Wheeler, in 1874, were found to contain the remains of a fauna, almost identical with that of the European beds in question. This was thought to be an important accession to American geology, as furnishing a basis for an estimation of the relative ages of the formations immediately above and below the Wahsatch horizon. The parallelism of the fauna includes the genera of reptiles, birds,

and mammals, and among the latter, of the types both of carnivorous and of hoofed quadrupeds. Gar-fishes (*Lepidosteus*) appear in both countries, and the predominant mammalian genera of both are *Coryphodon* and *Hyracotherium*. Gigantic birds inhabited the land; in New Mexico they belonged to the genus *Diatryma*, and in France to *Gastornis*. The New Mexican genus *Ambloctonus* represents the carnivorous *Palæonyctis gigantea* of the lignites of Soissons. The only marked difference between the faunas which the then state of discovery disclosed is the existence of the order *Teniodonta* in New Mexico, a type presenting characters of the *Edentata*, *Rodentia*, and *Creodonta*, which had not yet been found elsewhere.<sup>1</sup>

The characters of the mammalian fauna are very peculiar, displaying inferiority in many respects. Thus, among the flesh-eaters the brain of the *Oxyæna* is of reduced size, the hemispheres being especially small, while the olfactory lobes are very large and uncovered; and other Creodont genera present the same character. According to Gervais the genus *Arctocyon*, from the Suessonian, presents the same type of brain. The hoofed type, *Coryphodon*, shows a similar inferiority in the constitution of the brain.

So far as these observations have gone, they coincide with those made eight years ago by Professor Edouard Lartet of Paris. He states<sup>2</sup> that it is the result of a number of investigations undertaken in different horizons of the Tertiary strata, that the more we follow *Mammalia* into the antiquity of geological time, the greater is the reduction of the volume of the brain in comparison with the size of the head and the total dimensions of the body. Cuvier observed the form of the brain of the *Anoplotherium* in a cast of marl which was consolidated within the cavity of a skull of this animal, found in the gypsum of Montmartre. He says<sup>3</sup> "it has little volume, and is flattened horizontally; the hemispheres do not present convolutions, but we find only a shallow longitudinal impression on each. All the laws of analogy authorize us to conclude that our animal was greatly deficient in intelligence." In fact the skull of the *Anoplotherium* is six times as long as the cast of its cerebral hemispheres, and this animal, which in dimensions Cuvier compared to a medium-sized ass, had a brain smaller than that of the existing roebuck.

<sup>1</sup> See American Naturalist, 1876, p. 379.

<sup>2</sup> Comptes rendus, June, 1868.

<sup>3</sup> Ossements fossiles, iii., p. 44.

"I owe to the kindness of Professor Noulet, of Toulouse, the possession of a fossil cranium in which I have found the cast of a brain still more ancient than that of the *Anoplotherium* of Montmartre, since the fragment comes from the Eocene of the *Lophiodon* of Issel. In the brain of this animal (which I call provisionally *Brachyodon eocœnus*, on account of the slight elevation of the crowns of the molar teeth), there are no longer any convolutions, but only certain folds irregularly graduated; the olfactory lobes are much prolonged in front, and the cerebellum is entirely separated from the hemispheres. This brain is smaller in all respects, and less complicated in its structure than that of the *Cænotherium* described by Gratiolet; but it must not be forgotten that the latter animal is from a formation much more recent, that is, the inferior Miocene of Allier.

"In proportion as we approach the present period, the differences between the fossil brains and those of living species become less marked, as has also been observed with reference to the elevation of the crowns of the molars. Thus the deer and the antelopes of the Middle Miocene of Sansan present many convolutions, while the cerebellum remains moderately uncovered, and the olfactory lobes are very prominent. In the superior Miocene of Pikermi the brain of the *Hippotherium* (*Hipparion*) shows itself a little less rich in convolutions than that of the existing horse; and in a fragment of a skull of a monkey from the same locality, which I have been permitted to examine in the museum, the cerebellum is less completely covered by the hemispheres, and the median vermis is more prominent than in the living *Semnopithecus* of the types most nearly related to those of Pikermi. But in order to show more clearly this disproportion of the fossil brains in relation to those of living *Mammalia*, it is necessary that comparison should be made between species of the same family, or, better still, of the same genus. It has been possible for me to verify this point by the comparison of two carnivorous animals, the living *Viverra genetta*, and the extinct *V. antiqua* of De Blainville, from the inferior Miocene of Allier. From this it appears, that with a cranium one third longer and one fourth wider than the living *V. genetta*, the fossil *V. antiqua* has not a larger brain, and that this brain, more attenuated in its frontal convolutions, does not extend so far forwards. According to Gratiolet a great development of the olfactory lobes is a character of an inferior type. In fact the more we ascend into palæontological antiquity the more we find that the olfactory

lobes display a great development in comparison with the cerebral hemispheres."

The Wahsatch horizon is lower than the oldest above referred to by Professor Lartet, and it is interesting to observe how his generalization with reference to the characters of the mammalian brain is confirmed. The *Oxyæna forcipata* approaches more nearly to the viverrine type than to any other form of the *Carnivora*, although separated by a wide interval. I have been able to obtain a cast of the superior and anterior portions of its cranial chamber, from which it appears that the brain possessed characters of a much lower type than that observed in the *V. antiqua*. The olfactory lobes are enormously developed, rising higher than the hemispheres, from which they are not only entirely free, but are separated by a constriction of their basal portions. The hemispheres are not wider at the middle than the olfactory lobes, and have therefore elongated proportions. Their superior portion is without convolutions. Although not a marsupial, the general form in *Oxyæna* is more like that of the opossum than that of any other living animal, but is still lower in character. Its inferiority is especially seen in its small size. The mandibular ramus of the *O. forcipata* is about the size of that of the jaguar, but the brain, even with its large olfactory lobes, is only about two thirds as long, and one third as wide.

The ankle-joint presents a great simplicity of structure in most of the Wahsatch mammals, both flesh-eaters and hoofed types. The astragalus is nearly flat, and not like a segment of a pulley as in most existing *Mammalia*, and it therefore permitted but little flexure of the foot on the leg. The only exception to this rule is found in the species of *Hyracotherium* and allies of the order *Perissodactyla*, which number ten species out of a total of fifty-four.

As regards the elbow-joint a similar peculiarity was discovered to exist. In the majority of existing mammals, a ridge or bead divides the two facets of the humerus, which receive the ulna and radius respectively; it is called the intertrochlear ridge. In the ox and horse this ridge is very near the external border of the humerus. In the mammals of the Wahsatch beds this ridge was found to be wanting, excepting in the ten species of *Perissodactyla* above mentioned.

In respect to the teeth, no species presenting the selenodont or double-crescent bearing type had been found. Of the simpler types, where tubercles are united into crests, twelve species out

of fifty-four had been discovered. The teeth of the remaining forty-two species are bunodont or tubercular only, and in most cases simple forms of that type.

Another marked feature of the Suessonian or Wahsatch *Mammalia* is the possession by the greater number of them of five toes on both of the feet. The only probable exceptions to this rule are the ten species of *Perissodactyla* already mentioned, and perhaps a very few others. The genera of later and the present periods with three toes on all the feet, with two functional toes, and one toe, are wanting in this fauna.

It was also asserted that nearly all of the species were plantigrade in their mode of progression, that is, that the soles of the fore and hinder feet were applied to the ground, instead of being obliquely elevated behind, the heel thus appearing to form an angle of the leg, as in most living mammals. It is well known that among recent quadrupeds the *Quadrumania*, Plantigrade *Carnivora*, *Proboscidea*, and some *Rodentia* and *Edentata*, are plantigrade, while the others are digitigrade. The only species of the Wahsatch fauna possibly digitigrade are the species of *Perissodactyla*, already mentioned, although it was stated that the structure in a few of the other genera is yet unknown.

The agreement of clawed and hoofed (unguiculate and ungulate) mammals of this period in the general imperfection of the structure of the brain, of the ankle and elbow-joints, and in the position and number of the toes, was dwelt on as an important fact. It did not however warrant the separation of all the *Mammalia* of the Suessonian as a distinct order, on account of the exceptions pointed out. The clawed types presenting these characters have been since<sup>1</sup> defined as an order, under the name of *Bunotheria*, which it was believed might embrace also the existing *Insectivora* as a suborder. The ungulates of like character have already been erected into a distinct order, the *Amblypoda*, which includes two suborders, the *Pantodonta* and *Dinocerata*. The only mammalian orders of that period still existing are then the *Perissodactyla* and *Rodentia*.